

## INFLUENCE OF POLY-PROBLEM-SOLVING AND GUIDED-DISCOVERY STRATEGIES ON COOPERATIVE LEARNING ATTITUDE OF MALE AND FEMALE SENIOR SECONDARY SCHOOL STUDENTS IN BORNO STATE, NIGERIA

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### Abstract

*This study investigated the Influence of Polya Problem-Solving and Guided -Discovery - strategies on Cooperative Learning Attitude of Male and Female Senior Secondary Students in Borno state, Nigeria. Qausi-experimental with pre-test-post-test control groups design was adopted for the study. The population of the study comprise all the 614 government secondary schools in Borno State. The population of the study therefore is 5900 five thousand nine hundred students of SS11 (Male and Female). The sample consisted of 614 Government Senior Secondary 2 students made of 278 males 216 female and 120 mixed students the sample was drawn by the method of simple random sampling of sixty eight (68) senior secondary schools in Borno state. The research instruments used were: Algebra Performance Test (APT) and Algebra Attitude Questionnaires (AAQ). The research instruments was validated by the researcher and the reliability was 0.76 and administered to students. The research questions were analyzed using simple mean and standard deviation while the hypotheses were tested using t- test of independent, one way ANOVA at  $P < 0.005$  level of significance. The findings showed that: (i) there was a significant difference among the students when exposed to Polya Problem Solving, Guided Discovery than lecture method and based on the findings the mean difference of polya problem solving, guided discovery higher than lecture method (ii) there was a significant difference in performance and cooperative learning attitude between male and female students when using Problem Solving, Guided Discovery and those exposed to lecture method. Therefore there is the need for teachers to adopt polya problem solving and guided discovery strategies of teaching. Based on the findings, it is recommended that polya problem solving and Guided Discovery strategies should be adopted in teaching the Senior Secondary2 students for it enhance cooperative learning attitude of male and female students.*

**Key words:** Polya problem Solving, Guided discovery, Cooperative-Learning Attitude, Algebra

### Introduction

Massialas (2011), Posits that Polya Problem solving strategy is the strategy that prepares for future or near future challenges by facing real life or real life problems in their learning environment, and finding appropriate solutions to them. Every society expects from its education system a preparation that enables the individuals to be effective. Problem solving method places emphasizes on how to learn independently as a student. It is the most convenient approach to achieve the aims of teaching- learning process. The problem solving method is a activity based learning that is applicable to all disciplines including mathematics Many scholars have suggested different steps involved in the process of problem solving according to their respective finding and views, Polya (1975) outlined four stages namely:- understanding of the problem, devising a plan ,carrying out the plan and looking back

Suleiman (2010) argued for the use of problem-solving strategies to promote active learning, which encourages students to investigate, apply theory to real-world situations, and solve issues using their knowledge and abilities (Emerhiona et al., 2018). Adegoke (2017) and Olaniyan, Omosowo, and Nwankwo (2015) observed the effectiveness of Polya's problem solving method as an instructional method in teaching. This problem-solving technique involves small groups of students tackling an open-ended problem or inquiry, increasing their learning experiences through active engagement, unlike the lecture method, which allows students to passively receive information. As a result, the study sought to investigate the effects of the problem-solving method on students' academic achievement in algebra. Polya's problem-solving method consists of four steps: recognizing the problem, developing a strategy, implementing the plan, and reviewing the answer (Moore & Morton, 2019). Initially, the problem is thoroughly assessed to determine its requirements and restrictions, as well as what has to be discovered or proven. A problem-solving approach or plan is then developed, which may include techniques such as sketching, listing, or working backwards. The implementation phase entails carrying out the procedures stated in the plan, which could include computations, logical losses, or hypothesis testing. Finally, the answer is checked to confirm that it is correct, complete, and logically consistent. Furthermore, reflection on how to solve issues is used to gain insights and improve future solving skills. Polya's method is well known for its systematic approach to solving complex issues (Johson et al., 2020). By providing a formal framework for dealing with biological difficulties, students are urged to break down complex concerns into manageable steps, discover pertinent information, design problem solving strategies, and assess their responses. In the field of mathematics education, Polya's problem solving technique is expected to improve students' academic achievement.

The role of the teacher in guided discovery is to serve as facilitator of learning in which students are encouraged to be responsible, autonomous and construct their own understanding of concept. Hence, the activities are learner-centred, democratic and interactive. Garuma and Tesfaye (2012) corroborate that discovery learning is an intentional learning through problem solving under teacher supervision. It is a method through which the teacher provides illustrative materials for students to study on their own (Akinbobola and Afolabi, 2010). The method is an inductive and guides learners to discuss and organize ideas and process same by themselves (Acero, Javier and Castro, 2010). During guided discovery, the teacher invites students to initiate discussion and to react to other students (Garuma and Tesfaye, 2012). Learners' background knowledge and understanding of what is expected are important considerations for effective use of this strategy. It can improve attitude and understanding of algebra because students have background knowledge in algebra from junior secondary school. Self-discovery of more knowledge and better understanding of content can be achieved through guided discovery.

Guided discovery method of teaching is a technique that encourages students to take a more active role in their learning processes by answering a series of questions or solving problem. Mayer (2013) added that Guided Discovery method is based on the notion that learning takes place through classification and schema formation. Gellenstien (2014) Stressed that Guided Discovery strategy is essential as students are actively involved in the process of learning: that topics are intrinsically motivating, context are often meaningful than typical classroom exercise and study becomes investigative and reflective. Skills and new strategies are learned in the context, and students are more likely to remember concept and information, if they discover them on their own.

Mathematics is a leading logical science discipline upon which other sciences depend. Mathematics can be defined as the communication system for the concepts of shapes, size,

quantity and order used to describe diverse phenomena both in physical and economic situations. Mathematics is a tool used in science, technology and industries. The definition connotes that all sciences draw their inspirations from Mathematics which implies that Mathematics is a language of sciences. Ezeugo and Agwagah (2010), in their study looked at Mathematics as a scientific tool in realizing the nation scientific and technological aspirations. Also Usman (2017) considered Mathematics as a subject that encroaches into all aspects of human endeavor. He further described Mathematics as the live wire in the studies of various disciplines. It is based on the importance of Mathematics that the Federal Government of Nigeria made Mathematics a core subject from the primary through to the senior secondary level of education. However, literature reviews consistently show low performance of students at all levels of education in the subject mathematics

Attitude could be defined as a consistent tendency to react in a particular way-often positively or negatively-toward any matter. Attitude possesses both cognitive and emotional components. Algebra is one of the branches of mathematics taught at all levels of education in Nigeria (FME, 2013). It is defined as a branch of mathematics where the English alphabet (such as  $x$ ,  $y$ ,  $p$ ,  $q$  among others) are used to represent numbers in finding solution to a particular problem. The use of algebra to solve problem on equation or sentence is termed as algebraic process (Lucks, 2010). Gambo (2005) opines that algebra as a branch of mathematics that uses letters to represent numbers. in algebra the following topics: algebraic expansion liner and quadratic equation factorization among others as an aid for understanding discourse in the algebra classroom, and writing about algebraic thinking at the senior school level, students are expected to represent, analyze, and make generalizations about patterns. These patterns should be linear in nature, arising from a constant rate of change. In each pattern, the students should be able to use multiplication and addition to find the relationship between the two sets of numbers. Students should look at patterns through the use of tables, graphs, and symbolic representation (NCTM, 2000).

One of the most common explanations for gender disparities in algebra achievement has focused on attitude that students have towards algebra. Several studies have reported that there are gender differences in attitude towards algebra with female students showing more negative attitude than males. In general, most of the studies which, compared girls and boys, report that girls lack confidence, have causal attribution patterns, perceive mathematics as a male domain, and are anxious about mathematics ( Hyde et al , 2010; Ma, and Kishor (2013).The causes of the gender differences attitude to Mathematics attitude are found to be multifaceted. Researchers have identified parental and societal attitudes (Papanastasiou, 2007; Wong, 2004), and students' classroom experiences as being influential in making female students internalize the feeling that they are inferior to boys in mathematics. Studies have also considered classroom environments and teachers' classroom behaviors as factors associated with students' attitudes. Makinde (2015) has found that students' attitudes towards mathematics tend to be more positive in classrooms where students perceived greater leadership helping/friendly behaviors in their teachers.

### **Statement of the Problem.**

The poor performance of students in mathematics/algebra has caused substantial concern among education stakeholders. Mathematics curriculum, like other science courses, emphasizes the necessity of students participating in real-world problem solving and discovering oneself of knowledge throughout education. Unfortunately, mathematics educators tend to shun problem-solving and guided discovery strategies that expose students to real-world problems, instead preferring the lecture style, which frequently proves insufficient and unsuited

for supporting meaningful learning. During instruction, students are passively receiving information. It is imperative therefore to search for alternative strategies suitable and efficient for promoting high level of cooperative and attitude among students given these circumstances. A lot of studies have been conducted on the effectiveness of teaching strategies on students' performance in schools. But many of these studies were conducted on science subjects like chemistry physics biology (Udo, 2010, Ozomadu, 2016, Garuma and Tesfaye, 2012), there exist no research in senior secondary school in Borno. Also none of the previous studies conducted integrating the influence on two independent variables (polya problem solving guided discovery and one dependent variables cooperative learning attitude) in algebra with consideration for gender. The present study is considered necessary as it can fill the gap.

### **Objectives of the study**

1. To determine the Polya- Problem Solving Strategy on the cooperative learning attitude in algebra of male and female students of senior secondary school in Borno State, Nigeria.
2. To examine the Guided-Discovery strategy on the cooperative learning attitude in algebra of male and female students of senior secondary school in Borno State, Nigeria.
3. To determine the influence of Polya Problem-Solving and Guided Strategies on cooperative learning attitude of senior secondary school students in Borno State, Nigeria.

### **Research Questions**

The following research questions were formulated to guide the study.

1. What are the influence of Polya-Solving Strategies on the cooperative learning attitude in algebra of male and female students of senior secondary school in Borno State, Nigeria?
2. What are the influence of Guided-Discovery strategies on the cooperative learning attitude in algebra of male and female students of senior secondary school in Borno State, Nigeria?
3. What are the influence of Polya Problem-Solving and Guided Strategies on cooperative learning and attitude in algebra?

### **Hypotheses**

The following hypotheses were formulated

H01: There is no significant difference between Polya-Solving Strategies on the cooperative learning attitude in algebra of male and female students and lecture method of senior secondary school in Borno State, Nigeria

H02: There is no significant difference are the influence of Guided-Discovery strategies on the cooperative learning attitude in algebra of male and female students and lecture method of senior secondary school in Borno State, Nigeria.

H03: There is no significant difference between Polya Problem-Solving and Guided Strategies on cooperative learning and attitude and lecture method in algebra

### **Methodology**

The research design adopted in this study is quasi experimental /control group design, based on pre-test, post-test influence of Polya Problem Solving and Guided Discovery strategies on cooperative learning attitude with lecture method. The study involves three groups in which six classifications shall be designated. The first two classifications comprise male, female and the strategies, out of which two are experimental groups 1 2, and 3 the control group. In the same manner the second two classifications comprises male and female. Pre-test and Post-test are administered to both experimental and control groups.

Figure 1. Illustration of the Research Design

$$\begin{array}{cccccc}
 EG_1 \rightarrow & O_{1A1} \rightarrow & X_1 \rightarrow & O_{2A2} \rightarrow & O_3 \\
 EG_2 \rightarrow & O_{1A1} \rightarrow & X_1 \rightarrow & O_{2A2} \rightarrow & O_3 \\
 CG \rightarrow & O_{1A1} \rightarrow & X_0 \rightarrow & O_{2A2} \rightarrow & O_3
 \end{array}$$

**Population and Sample of the study**

The population of the study comprises all the public senior secondary schools (SS11) in the four educational zones of Borno State Teachers Service Board (BSTSB) .There are sixty eight senior secondary schools (SS2) with a population of five thousand nine hundred ((5900) students with three thousand and twenty (3020) males. One thousand nine hundred and twenty (1920) females, and from Mixed schools nine hundred and sixty (960). However, for the purpose of this study the target population used is senior secondary schools (SS2) students in Borno State.

Sample schools are. Male single 278, female single 216 are considered as sample size, and the selection was carried out by simple random sampling. Simple random sampling techniques is used to select the twelve schools out of the four zones .MM (3) schools, Monguno (3) schools Gwoza (3) schools, and Biu (3) schools. A total of 12 government schools are used as a sample. The following four instruments were used in the study;-

- (i) Algebra Performance Test (APT),
- ii Algebra Attitude Questionnaire (AAQ)

**DATA ANALYSIS**

**Table 1:** Descriptive statistics of the pre-test and the post-test results of the Independent variable and Dependent variable of teaching Algebra among male and female senior secondary schools students

| Strategies             | Pre-Test   |       |              | Post-Test  |       |              |
|------------------------|------------|-------|--------------|------------|-------|--------------|
|                        | N          | Mean  | SD           | N          | Mean  | SD           |
| <b>Problem Solving</b> | <b>122</b> | 31.37 | <b>9.57</b>  | <b>122</b> | 33.38 | <b>13.39</b> |
| <b>Lecture Method</b>  | <b>377</b> | 29.80 | <b>11.15</b> | <b>377</b> | 66.07 | <b>11.56</b> |

Table 1 showed the mean scores of students taught using problem solving and influence on cooperative learning attitude in pre-test and post- test than lecture method From the table, it could be seen that students taught using polya problem solving strategy obtained mean score of 31.37 while lecture 29.80 and in the post test. The students taught with polya problem solving obtained a mean score of 31.37 while lecture method 33.38 in the post-test. A comparison of the pre-test and post- test of the two groups showed that the students taught using guided discovery strategy, obtained a difference of 36.27and enhance cooperative learning attitude than lecture method.

**Table 2:** Summary of Descriptive statistics on the Gender difference when taught using polya problem solving, guided discovery and lecture method on Cooperative Learning Attitude of secondary school students

| Strategies                   | Gender | N  | Mean  | SD    | MD    |
|------------------------------|--------|----|-------|-------|-------|
| <b>Polya Problem solving</b> | Male   | 61 | 63.15 | 64.59 | 12.71 |
|                              | Female | 62 | 62.59 | 12.71 | 1.44  |

|                         |        |     |       |       |      |
|-------------------------|--------|-----|-------|-------|------|
| <b>Guided discovery</b> | Male   | 62  | 63.50 | 68.55 | 5.05 |
|                         | Female | 60  | 11.25 | 14.96 |      |
| <b>Lecture method</b>   | Male   | 184 | 11.74 | 11.74 | 0.35 |
|                         | Female | 193 | 11.39 | 11.39 |      |

**Table 2** showed the mean scores of attitude 64.84 of female students while mean scores of attitude 63.70 of male taught using polya problem solving, also mean scores 68.55 of female students while mean scores 63.50 male taught using guided discovery and mean scores 11.74 of male students while mean scores 11.39 taught using lecture method in pre-test and post-test. A comparison of the pre-test and post-test of the four groups showed that female students taught using polya problem solving perform better than male students taught using guided discovery. While mean scores 11.74 of male and mean scores 11.39 of female taught using polya problem solving and guided perform better than lecture method. Thus a mean difference of 1.44, 5.05 and 0.35 between male and female taught with polya problem solving and guided discovery strategies and lecture method. Therefore students taught algebra using polya problem solving and guided discovery strategies performed better than those taught lecture method with a difference of 1.14, 1.44 and 5.05.

**Table 3:** Descriptive statistics of the pre-test and the post-test results of the effect of Polya problem solving and guided discovery on Cooperative Learning attitude and lecture method in algebra among male and female secondary school students

| Teaching Strategy         | Pre-Test   |              |              | Post-Test  |              |              |
|---------------------------|------------|--------------|--------------|------------|--------------|--------------|
|                           | N          | Mean         | SD           | N          | Mean         | SD           |
| <b>Polya Problem Solv</b> | 128        | <b>31.37</b> | <b>11.15</b> | <b>377</b> | 63.86        | <b>11.56</b> |
| <b>Guided discovery</b>   | <b>128</b> | <b>29.84</b> | <b>10.89</b> | <b>128</b> | <b>64.24</b> | <b>13.12</b> |
| <b>Lecture method</b>     | <b>123</b> | <b>28.62</b> | <b>9.65</b>  | <b>123</b> | 33.38        | <b>12.67</b> |

Table 3 showed the mean scores of students taught using polya problem solving and guided discovery strategies on the cooperative learning attitude and lecture method in pre-test and post-test. From the table, it could be seen that students taught using polya problem solving and guided discovery strategies obtained mean score of 31.37, 29.84 while lecture method 28.62 in the pre-test and 63.86 64.24 while lecture method 33.38 in the post test. The effect on the cooperative learning attitudes polya problem solving, guided discovery and lecture method mean score of 63.86 in post test and 33.38 in the post-test. A comparison of the pre-test and post-test of the three groups showed that the students taught using polya problem solving and guided discovery strategies has higher scores than lecture method.

### Hypotheses Testing

**Table 4.** Summary of the independent Sample t-test on the mean difference of male and female Students taught polya problem solving strategy on cooperative learning attitude and lecture method

| Variable                     | N   | Mean  | SD    | df  | t      | p-value |
|------------------------------|-----|-------|-------|-----|--------|---------|
| <b>Polya Problem Solving</b> | 128 | 64.24 | 13.12 | 255 | -20.73 | 0.00    |
| <b>Lecture Method</b>        | 129 | 32.95 | 10.99 |     |        |         |

Results from Table 4 revealed that there was significant influence on students taught using polya problem solving strategy and those taught by lecture method with p-value (0.00) less than the level of significant (0.05). The mean score of the students taught using polya problem solving strategy perform better. Therefore, polya problem solving strategy was effective in teaching algebra than lecture method and enhance learning.

**Table 5:** Summary of the independent sample t-test on the mean difference of male and female students taught guided discovery strategy and Lecture method on cooperative learning attitude

| Variable                | N   | Mean  | SD    | df  | t      | p-value |
|-------------------------|-----|-------|-------|-----|--------|---------|
| <b>Guided discovery</b> | 124 | 60.43 | 13.11 | 246 | -18.63 | 0.00    |
| <b>Lecture Method</b>   | 123 | 31.34 | 11.23 |     |        |         |

Results from Table 5 revealed that there was significant difference of the students taught using guided discovery strategy and lecture method on cooperative learning attitude with p-value (0.00) less than the level of significant (0.05). The result further revealed that the mean score of the students taught using guided discovery strategy is higher than lecture method and enhance learning. Therefore, guided discovery strategy was more effective in teaching algebra and enhance learning than lecture method.

**Table 6:** Summary of the one way analysis of variance on the mean difference of students' influence when taught using polya problem solving, guided discovery and lecture method

| Sources of variation | Sum of squares | Degrees of freedom | Mean square | F-ratio  | P-value |
|----------------------|----------------|--------------------|-------------|----------|---------|
| Between groups       | 184393.41      | 3                  | 61464.47    | 4355.636 | 0.00    |
| Within groups        | 113420.62      | 250                | 152.0380    |          |         |
| Total                |                | 253                |             |          |         |

Results from Table 6 revealed that there was significant influence on the mean performance of students taught using polya problem solving and guided discovery than lecture method on cooperative learning attitude because the p-value (0.00) is less than the level of significant (0.05). The post-hoc result revealed that there was no significant difference in the mean scores polya problem solving and guided discovery with means 64.24, 63.86 and 66.07 respectively. Therefore, polya problem solving and guided discovery are more effective in teaching algebra than lecture method and enhance learning.

**Table 7:** Summary of the independent sample t-test on the gender difference of students' influence using polya problem solving, guided discovery on male and female cooperative learning attitude

| Strategies           | Gender | N  | Mean  | S.D   | df  | T      | p-value |
|----------------------|--------|----|-------|-------|-----|--------|---------|
| <b>Polya Problem</b> | Male   | 62 | 63.15 | 12.71 | 121 | -0.631 | 0.529   |

|                         |        |     |       |       |     |             |
|-------------------------|--------|-----|-------|-------|-----|-------------|
| <b>Solving</b>          | Female | 61  | 64.59 | 12.69 |     |             |
| <b>Guided discovery</b> | Male   | 60  | 63.5  | 14.96 | 120 | -2.11 0.037 |
|                         | Female | 62  | 68.59 | 11.25 |     |             |
| <b>Lecture Method</b>   | Male   | 193 | 11.74 | 11.74 | 375 | 0.599 0.549 |
|                         | Female | 184 | 11.39 | 11.39 |     |             |

Results from Table 7 revealed that there was no significant influence difference between male and female students taught polya problem solving, and guided discovery on male and female cooperative learning attitude with p-values 0.627, 0.529 and 0.549 greater than the level of significant ( while there was significant difference between male and female students when taught algebra using polya problem solving and guided discovery with p-value 0.037 and 0.529 than lecture method of male and female students.

## Discussion

The study revealed that male and female students taught using polya problem solving and guided discovery perform and enhance cooperative learning better than lecture. Female students perform better than male taught using problem solving, guided discovery than lecture method .There was no difference in mean performance scores of male and female students taught guided discovery and polya problem solving male and female have same cooperative learning attitude and gender differential has no impact on the attitude of students.

The t-test for independent samples revealed that the p values are less than & 0.005 significant level therefore the null hypotheses that says there is no significant difference is rejected. The findings showed that there was a significance difference between the teaching strategies polya problem solving and guided discovery has more effects on cooperative learning attitude the male and female students. One way analysis ANOVA shows that the p values are all less than & 0.005 significant level, this shows that, polya problem solving and guided discovery are more effective and reliable of enhancing cooperative learning attitude in students. The study also revealed that all the p values are greater than the & 0.005 significant level therefore no significant difference in performance between male and female taught, polya problem solving and guided discovery than lecture method. while there was significant difference in performance between male and female taught using polya problem solving, guided discovery with p values  $0.037 < 0.005$  than lecture method.

## Conclusion

Based on the findings of this study it can be concluded that; Algebra performance test according to gender reveals that both sexes in the experiment groups show significant effects when exposed to treatment. The finding on student's cooperative learning attitude after exposure to polya problem solving and guided discovery strategies has perform and enhance their cooperative learning attitudes. The students enjoyed teaching and learning of algebra using polya problem solving and guided discovery strategies, since these allowed them to have interaction, discussion before coming to an acceptable possible solution to a given problem. These two strategies kept every learner very active and involved at every stage of finding solutions to problems. Thus cooperative learning attitude of learners is favorable and this in turn improved their algebra performance. Therefore, one can

state categorically says that polya problem solving or the guided discovery instructional strategies could be used by Mathematics teachers in the teaching of algebra.

Since the use of polya problem solving and guided discovery learning enhances students' performance better in algebra, it follows that curriculum planners should create the awareness of these strategies to teachers by including it in the mathematics curriculum of the senior secondary schools. From this findings, it has becomes clear that the students needed an alternative strategy to teaching algebra, which this study proudly offers. The study gives the students the opportunity to learn algebra from their own perspective, which helps them appreciate and enhance cooperative learning attitude to mathematics better.

### **Recommendations**

Based on the findings of this study, the researcher made the following recommendations:

1. There is a need for collaborative effort and change of attitude among male and female students to enhance cooperative learning attitude and performance
2. Teachers are expected to vary their teaching strategies and based on students groups collaborative and experience to enable the learners easily what is being taught in both classroom and outside.
3. Teachers are expected to used teaching strategies polya problem solving and Guided Discovery, to enhance cooperative learning attitude and performance among male female students

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